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The Permian-Triassic of the Gartnerkofel-1 Core (Carnic Alps, Austria): Remarks on the Natural Gamma Ray Log and Density Log

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With 2 Text-Figures and 1 Plate (appendix in pocket)

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Carinthia
Carnic Alps
Permian/Triassic Boundary
Gamma Ray Log
Density Log

Contents

Zusammenfassung

Dolomite, Kalke und Muschelkalkkonglomerat der Bohrung Gartnerkofel-1 zeigen bei niedrigen Gammawerten meist hohe Dichten. Eingeschaltete tonige Lagen (oberer Teil des Perms bis Skyth) bewirken erhöhte Gammazählraten. Ein niedriger Pegel der natürlichen Gammastrahlung hält von der ursprünglich bei 187,4 m angenommenen Perm/Trias-Grenze bis zu einem plötzlichen Anstieg bei 218 m an. Die letztlich akzeptierte Perm/Trias-Grenze ist offensichtlich durch einen neuerlichen scharfen Abfall zu niedrigen Gammazählraten bei 224,5 m gekennzeichnet.

Abstract

Dolomtite, limestone and Muschelkalk conglomerate of well Gartnerkofel-1 show low gamma counts and predominantly high densities. Intercalated shaly beds (upper part of Permian until Scythian) cause high gamma rates. A low gamma level downwards from the originally assumed Permian/Triassic boundary at 197.4 m is followed by a sharp rise at 218 m. The now accepted Permian/Triassic boundary is obviously defined by a sharp drop back again to low gamma counts at 224.5 m.

1. Introduction

As a supplement to the lithostratigraphical and geochemical analysis of the Gartnerkofel-1 core, geophysical down-hole logging was accomplished on completion of the hole. Studies of heat-flow-density measurements for temperature and thermal conductivity which were also planned at the beginning of this project could not be carried out due to loss of water and fractioning of the dry dolomitic sequence.

Down-hole logging was carried out on October 3rd, 1986, using the Japanese OYO Geologger for natural gammy-ray and density logging (Text-Fig. 2).

2. Measuring conditions

There were special environmental conditions for well logging purposes: the wellbore was a cased and dry hole.

The gamma ray log is moderately influenced by the casing. A cross plot of natural gamma ray logs in cased holes and in the equivalent open holes is linear, although the relative change in gamma ray counts is less in cased holes due to the attenuation of the gamma rays by the casing.

Air instead of some kind of mud in the hole means less attenuation of the gamma rays, and is therefore

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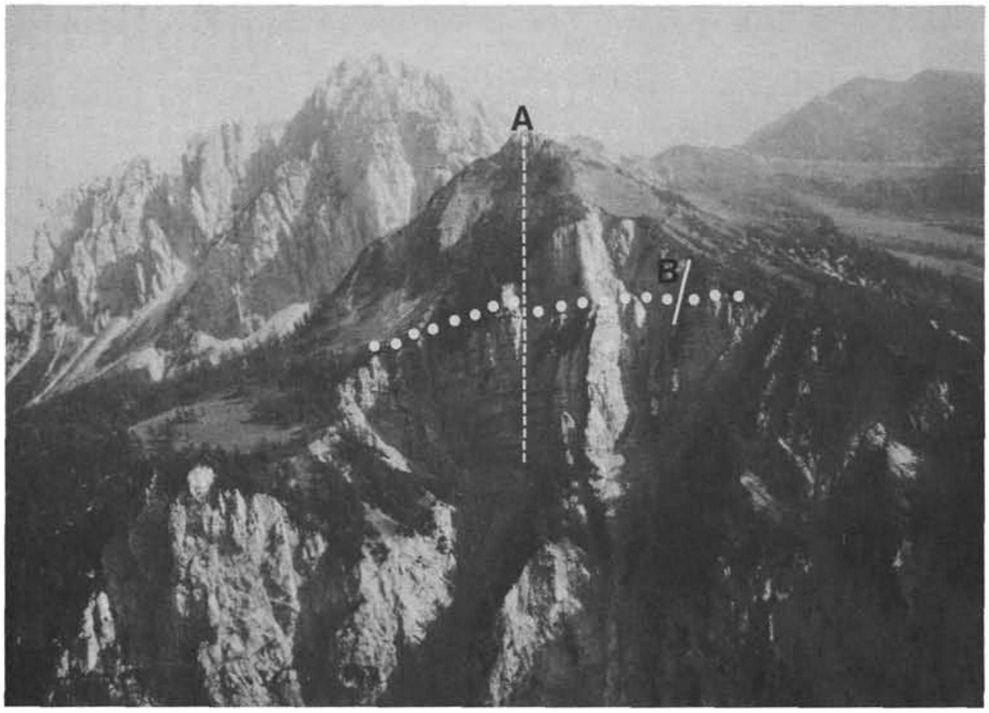
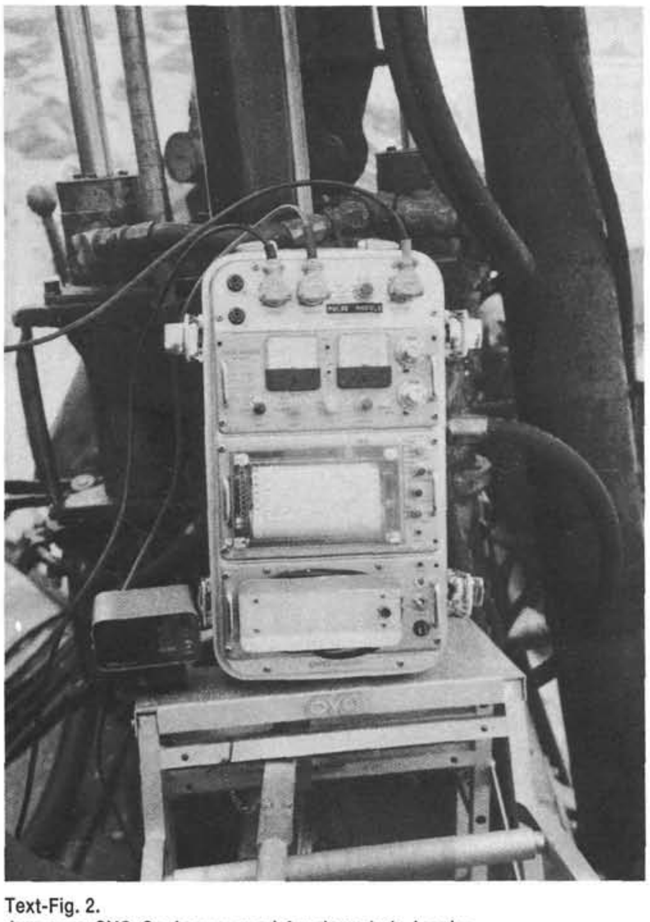


Text-Fig. 1.
Aerial photograph from the north of the Reppwand with the Gartnerkofel (2195 m) in the background.
A: Drill site on Kammleiten (1998 m);
B: Top of the outcrop section.
Dotted line indicates the Permian–Triassic boundary between the Bellerophon Formation (below) and the Werfen Formation above.
Photo: G. FLAJS, Aachen.

favourable for maintaining a high level of ray counts. But there might be some deflections due to cavities (not controllable by a caliper log) and the unknown eccentricity of the sonde. In combination with low density indications reduced gamma ray counts could instead be interpreted as indicative for washouts or cavities.



Text-Fig. 2.
Japanese OYO Geologger used for down-hole logging.

Low gamma readings are normally characteristic for most sandstones, limestones and dolomites, high readings for shales, potassium salts, acid and intermediary magmatic rocks (Gartnerkofel 30–24 m), that is generally all materials containing U, Th or K.

The density log is very much influenced by the casing. As there were two different casing strings (HQ to 220.5 m, NQ to 330 m) corrections had to be made. As the hole was empty (air instead of mud) the calibration might not be quite correct. Density probes are usually calibrated for mud filled holes. Hole size changes have also much influence on the density reading, especially in air filled holes and when running the log through casing. In this case the probe cannot be pressed against the rock wall and might have different distances to the rock depending on the possibly changing eccentric position of the casing in the hole.

So the density log should mainly be regarded as a relative reading of densities, strongly indicative for cavities if values go down to the range of 1.5 to 2 g/cc, or below that level.

3. Interpretation

The geophysical logs are reproduced in Plate 1 (in pocket) along with the well-site lithologic log of the core.

A rough rule of interpretation of the Gartnerkofel-1 logs might be as follows:

Density log	Gamma-ray log	Interpretation
low	low	cavities (faulting?)
high	low	dolomite, limestone, conglomerate
low	high	shales
medium	high	andesitic

The originally assumed P/Tr boundary at 187.4 m is characterized by a distinct reduction of natural gamma ray readings below that depth, persistent down to the depth of 209.5 m but with a sharp rise at 218 m. The now accepted P/Tr boundary at 224.5 m is obviously defined by the sharp drop of this high gamma level to the low gamma counts in the Bellerophon Formation.

Low gamma ray readings are generally indicative for the Muschelkalk Conglomerate and those sections, where dolomite is predominant. The upper part of the Scythian down to 187.5 m and the Permian from bottom hole up to 218 m show changing radioactivities, obviously reflecting a high incidence of intercalated shaly interbeds.

No clear evidence of a repetition of a geologic section could be found from the logs. But there is a gradational similarity at 224.5 m and 187.5 m: at these depths there is a sharp rise of radioactivity in up-hole direction, indicating regressional events with argillaceous sedimentation.

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Well-site

GARTNERKOFEL – 1

Date	Oct. 1986	Mud	Water
Bottom hole depth	330 m	Instrument	OYO
Hole diameter	72 mm	Scale	1:200
Casing diameter	63 mm	Operator	R.Schmoeller

Geology

Color	Lithology	Notes
Light gray	Dolomite	Ooids
Medium gray	Limy Dolomite	Fossils
Dark gray	Limestone	Bioturbation
Black	Shale	Stylolite
Greenish	Marl	Flaser bedding
Brownish	Siltstone	Laminar bedding
Red or brown	Sandstone	Tempestite
	Conglomerate	Faulting
	Breccia	Dip
	Volcanics	Birdseye texture